The Marketing of Magnesite

By R. W. STONE
Assistant State Geologist, Harrisburg, Pa.

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Crude, Caustic Calcined and Dead-Burned Material Sold—Domestic Industry Greatly Stimulated by the War—Principal United States Production from California and Washington—Chief Consumption in the East in Refractory and Cement Trade

By R. W. Stone
Assistant State Geologist, Harrisburg, Pa.

MAGNESITE is a little known but important non-metallic mineral. As an article of commerce it is used by comparatively few industries and they may rarely see it in the raw or crude state. The mineral is a magnesium carbonate, composed largely of magnesium oxide and carbon dioxide. The oxide is used, the gas is wasted. As the gas forms nearly 50 per cent of the weight, and is easily removed by heating. the rock is burned at the mine to save expense in shipping.

Magnesite occurs in two distinct forms, amorphous and crystalline. Amorphous magnesite, the common form, is a fine-grained, compact, white or cream-colored mineral; it has concoidal porcelaneous fracture, and is hard to scratch with a knife; it is usually found in veins or masses in serpentine. The deposits in California, Mexico, Venezuela, and Greece are of this type. Crystalline magnesite resembles medium to coarse-grained marble, and occurs as replacement masses in metamorphosed limestone, dolomite or associated sediments. The principal deposits of this class are in the State of Washington, Quebec, Austria, and Czechoslovakia.

Magnesite has two principal uses: as a refractory lining for metallurgical furnaces, and as a plastic material for floors and walls of buildings. It is put on the market in two forms, dead-burned and caustic calcined.

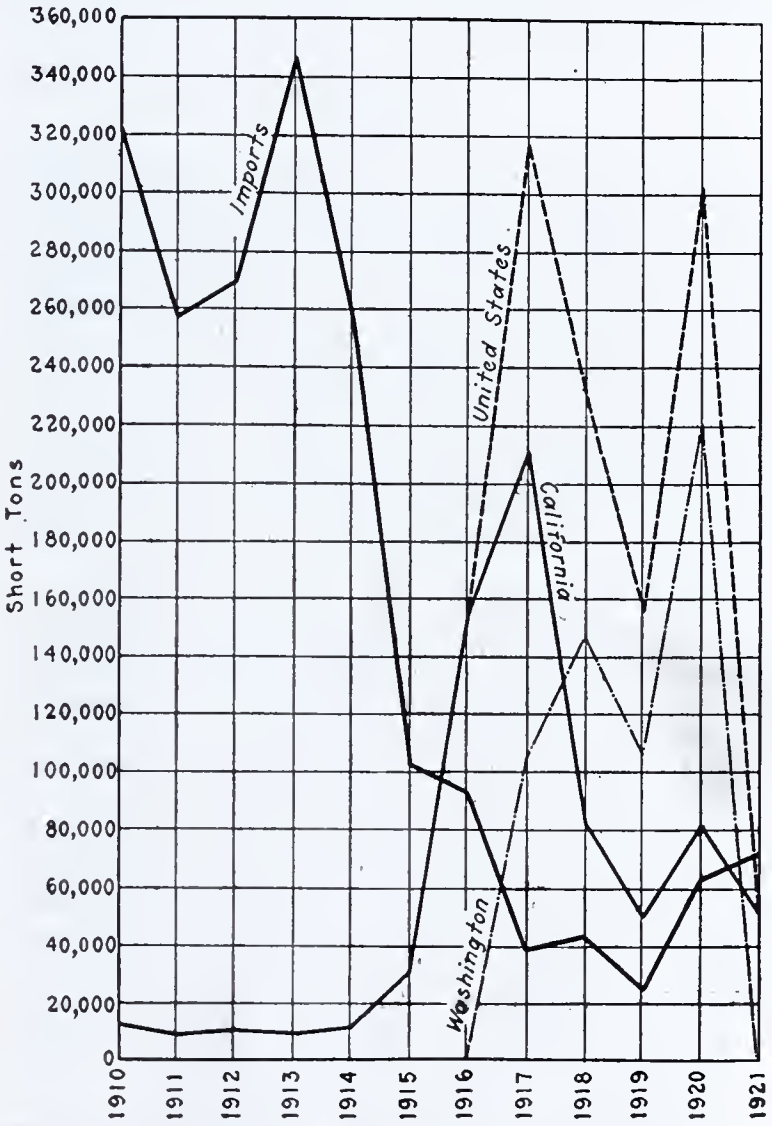
Dead-burned magnesite, or refractory calcines, is the better known and, so far, the most used. It is employed in grain form to make the bottom of open-hearth steel furnaces and as brick for lining furnaces and converters used in making steel and copper, and in rotary kilns. The consumption for these purposes may have reached its peak, because of changes in processes and the introduction of substitutes for magnesite.

Caustic calcined magnesite is used for the manufacture of oxychloride or Sorel cement. The use of magnesite cement for floors and as interior and exterior wall plaster is growing in this country and has an unlimited market to develop. Other uses of caustic calcines are for pipe and furnace covering, molded into sinks, bowls, and other sanitary fixtures, for light carbonate, and other minor products.

Magnesite in the dead-burned form is used by manufacturers of refractory products, in plants east of St. Louis, and in the caustic form by manufacturers of oxychloride cement in this same region and on the Pacific Coast. Much of the dead-burned magnesite used in the eastern United States, however, is imported from Europe. Before mining in Washington came to a standstill in December, 1920, the crude magnesite was being converted into synthetic ferromagnesite at the mine, and at the peak of production in California practically all the raw stock was calcined before marketing.

The chief markets for dead-burned magnesite are the steel plants between Baltimore and Chicago and for caustic magnesite the larger cities of the eastern United States and the Pacific Coast.

The consumption of magnesite in the United States has had a wide annual range in the last ten years, but in normal times approximates 300,000 short tons stated in terms of crude material. Consumption is production plus imports, as there are no exports.



Magnesite production of Washington, California and the United States and imports 1910 to 1921

The following table, taken from "Mineral Resources of the United States," gives the domestic production and the imports converted to the equivalent in the crude form.

TABLE I. CRUDE MAGNESITE CONSUMED IN THE UNITED STATES 1911-1921 IN SHORT TONS.

Year	Domestic Production	Imports	Total	Percentage Of Imports To Total
1911	9,375	270,098	279,473	97
1912	10,512	268,309	278,821	96
1913	9,632	347,428	357,060	97
1914	11,293	256,988	268,281	96
1915	30,499	102,913	133,412	77
1916	154,974	93,885	248,859	38
1917	316,838	38,208	355,046	11
1918	231,605	43,530	275,135	16
1919	156,226	25,321	181,547	14
1920	303,767	63,110	366,877	17
1921	47,904	67,569	115,473	58

The accompanying diagram shows very clearly the small domestic production and heavy imports up to

1914, the greatly increased output in both California and Washington during the war, the precipitous decline of imports when ocean shipping was restricted, and lastly the partial recovery of imports and marked decline of domestic production since 1920.

The minimum consumption was in 1915 when imports were cut off, owing to the European War, and in 1919, when the steel industry was stagnant. Consumption peaks were 1913, a normal pre-war year before imports were reduced; 1917, the year of war-peak production; and 1920, representing the post-war partial recovery of business.

In 1922 very little, if any, magnesite is being mined in this country for refractory purposes. The steel plants in California may be using local magnesite but the big steel centers in the Eastern States are using Austrian magnesite.

Chemical and Physical Requirements Variable

Crude Magnesite.—It is customary to ship crude magnesite in bulk and in lump form. It should be free from country rock and other impurities. For calcining in shaft kilns, the rock is used in lumps but for proper treatment in a rotary kiln it is pulverized. Manufacturers of Epsom salts and other chemicals require crude magnesite in lumps ranging from 4 to 14 in. in size because they find that lump material dissolves best in their solution tanks. Some users of crude magnesite believe that they should have white ore but those who have studied the question find that iron in quantities which stains the ore rather deeply does not injure their products.

Caustic Calcined.—No very definite limits can be set for the chemical composition of caustic calcined magnesite. Magnesium oxide content ranges from 72 to 90 per cent, lime from 2 to 6 per cent, silica from 3 to 15 per cent, and ignition loss from 1 to 15 per cent. It has been found impossible to make fixed limits for maximum percentage of any impurity, for with the possible exception of active or free lime, no impurity exerts a decided effect on the oxychloride cement reaction. The value of magnesite in an oxychloride cement accordingly cannot be determined from chemical composition. The ordinary specifications for size of plastic calcined magnesite are 97 per cent through a 100-mesh screen and 75 per cent through a 200-mesh screen, although greater fineness is sometimes desirable. Color is held to be an object by some users, but if the color is not deeper than deep cream, it is doubtful whether any difference in the finished cement product can be distinguished when compared with a cement made from pure white magnesite. Pure white ore ordinarily commands a premium and very dark plastic calcined magnesite is usually somewhat cheaper than the white or light cream material.

Caustic calcined magnesite should not be exposed to moist atmosphere for a long time before use, for it will lose its setting quality.

Dead Burned.—As its name implies, dead-burned magnesite is inert, has no reactive property with its chloride. Its function is simply to resist heat and basic fluxes. Therefore, in theory at least, any impurities which tend to decrease its refractoriness are undesirable. Too much silica is, of course, bad. But curiously, if the dead-burned calcines are entirely free from silica, or iron, or lime, they are almost useless to the trade, at least in the present technologic processes. Without these impurities they will neither frit together into grains in the calcining kiln nor will they bond together into brick. Therefore, although they all tend to reduce the refractoriness, small quantities of silica, iron and lime, perhaps 8 to 14 per cent of the total volume, are necessary to form the bond which results in the "grain" formation in the kiln. They form fusible slags and hold the refractory magnesium oxide together.

Austrian Product Hitherto Accepted as Most Satisfactory

Up to the present time, Austrian magnesite has been generally accepted as the most satisfactory refractory magnesite. In crude form it carries about 4 per cent of iron and alumina sesqui-oxides, 2 to 3 per cent silica, and ½ to 1½ per cent calcium oxide. As it takes about 2.2 tons of crude to make 1 ton of dead-burned, these percentages are doubled in the calcined product. As practically all American magnesite has a low percentage of iron, the principal producer of magnesite for refractory purposes mixed enough iron ore with the crude magnesite to bring the content of iron and alumina in the calcines up to about 7 per cent.

Dead-burned magnesite for use in the refractories trade must be low in silica (maximum 7.5 to 8 per cent) and low in lime (1.5 to 3 per cent). The material must have practically no loss on ignition and show no shrinkage on heating up to 3,000 deg. F.

Grain magnesite to be used in open-hearth steel and copper furnaces should be nodular and not over ⅝ in. in diameter; it may, though it does not always, command a slight premium over dead-burned magnesite in lump form.

There are no market requirements regarding the allowable percentages of impurities, or of moisture. The price is not influenced by size or shape of particles. A mixture of sizes ranging from approximately ½ in. to extremely fine particles is preferred to material which is either all fine or all coarse.

Producers Rarely Ship Less Than Carloads

In both the refractories and plastic trade, little magnesite leaves the producer's plant in less than carload lots. The minimum carload is about 20 tons and there is no maximum excepting size of cars or about 50 tons. Lots smaller than carloads are handled by jobbers at consumption centers.

There are no premiums and penalties provided for in payment for purchases, nor tolerances in weighing and analysis of magnesite for refractories, although some orders specify maximums and minimums in chemical composition. Terms are usually 30 days net. When magnesite is to be used for chemical purposes, a premium or penalty for magnesium oxide content is sometimes allowed. A 1-per cent increase in magnesium oxide content over the specified limit is frequently allowed a 50-c. premium; and there may be a corresponding penalty if magnesium oxide is reduced.

Sampling of Crude Lump Difficult

Standard sampling methods are used and the quality is judged from analyses or tests and appearances. There are no standard tolerances. The sampling of crude lump magnesite by the buyer is decidedly difficult and it is doubtful if any is done regularly and satisfactorily. The chemical manufacturer judges quality largely by the behavior of the material in his solution tanks.

Plastic calcined magnesite is sampled by taking small quantities from many packages in a shipment, mixing, and making tests on the mixed sample. Chemical analysis is sometimes made, but most reliance is placed on physical tests of oxychloride cement made from the sample. Standard tests for plastic calcined magnesite should shortly be developed by a committee of the American Society for Testing Materials.

Dead-burned magnesite is sampled and analyzed by standard methods. Quality, however, is judged by appearance as well as from analyses.

Mode of Shipment Varies

Crude magnesite is shipped in lump form, either in box cars or open-top cars. Plastic calcined magnesite preferably is shipped in paper bags, paper-lined burlap sacks, containing 150 lb. each, and in paper-lined barrels. Some calcined magnesite is shipped from the Pacific Coast in bulk in box cars to grinding plants in the Central and Eastern States. The ground magnesite is later packed in sacks of 150 lb. with or without paper lining. Dead-burned magnesite is ordinarily shipped in bulk in box cars. Water does not damage this material. If in grain form, it is sometimes or usually shipped in bags containing 200 lb.

Only foreign calcined magnesite always arrived in sacks, and for some time after foreign shipments ceased, steel works continued to ask for dead-burned magnesite shipped in sacks, because so many sacksful was the customary measurement among the men using grain magnesite in furnace bottoms. The steel works, however, became reconciled to using domestic magnesite shipped in bulk.

Some specify a minimum carload at 80,000 lb., and to secure the commodity rate on the railroad the material is released to a valuation of $10 per ton. The maximum carload is 50 tons, or the limit of car capacity. For local shipments in California, cars of 30 tons may be shipped.

Insurance Not Customary

In general, magnesite is never insured except against loss at sea. Plastic calcined magnesite is not ordinarily insured in transit. Damage is done sometimes by a leaky car roof but carriers promptly allow claims for such damage.

Magnesite is quoted on a fixed price per ton. Usual terms are net cash thirty days from date of invoice. Most of the plastic calcined magnesite shipped from California is sold on a sight draft basis. In some cases thirty or forty-five-day trade acceptances are allowed. Jobbers and local dealers sell small lots on more lenient terms, but little long-term business is handled by the producer.

Less Than Twenty Years Supply in Washington and California at 1920 Production Rate

The State of Washington could produce dead-burned magnesite sufficient for the steel industry, and Washington and California could supply the caustic calcines for the magnesite stucco and flooring industries, at the 1920 rate of production, for comparatively few years. That is, these states have the ore, and their mines and quarries have the capacity to meet the needs possibly for less than twenty years, if this country continued to consume magnesite as fast as in 1920 and relied wholly on the domestic supply.

Normally almost no magnesite leaves the mines in the crude condition. Marketing problems pertain, therefore, only to caustic and dead-burned magnesite. Caustic-burned magnesite has the entire United States for its market. Probably California and the Chicago district use more magnesite for stucco and flooring than other parts of the country, with the New York-Philadelphia district ranking third. Pacific Coast magnesite takes care of the Western and Central States, and even secures business in New York and other eastern cities. The Atlantic Coast, however, has received calcined magnesite from Greece for many years. Importations from Greece were discontinued in 1916 but resumed in November, 1920. An American firm operating in Venezuela brought 2,300 tons in the eastern market in September, 1920, and 1,100 tons in December, 1921. It is only natural, in view of the low ocean rate and high cost of transcontinental freight, that the Eastern States should buy foreign magnesite. Indeed, the producers of domestic magnesite would seem to be fortunate in having so much of the United States for an exclusive market.

The market for dead-burned magnesite is a very different matter. The steel industry is the large consumer, which means that the principal market is east of the Mississippi River and north of a line through the mouth of the Ohio.

Steel Industry Using Dead-Burned Magnesite from Europe

Until 1917, the refractory trade had been supplied with magnesite from Austria and Hungary. Then, under necessity, magnesite from our Western States and from Canada was used. The price, of course, rose. As a result efforts were made to find a cheaper substitute and sintered dolomite was employed as a refractory lining for metallurgical furnaces. The steel industry is now using dead-burned European magnesite as it did before the war, paying about $28 to $30 f.o.b. cars Baltimore, Md. The plant that produced most of the domestic dead-burned ferromagnesite during the latter part of the war has been closed since Dec. 31, 1920, presumably for lack of orders at the price asked. It is believed by some that if for any reason the price of dead-burned magnesite should be materially increased over that paid now for Austrian grade, the steel industry would discontinue the use of magnesite and substitute sintered dolomite. Of course, a sufficient reduction in price of the domestic material would put it again on the market.

Dead-burned magnesite used in the refractories trade has no special marketing problems because of the physical and chemical character of the material. It is not injured by exposure to weather and large stocks can be held. Practically all of the dead-burned magnesite consumed in this country is sold by a few of the larger refractories companies, as the American Refractories Co., General Refractories Co., Harbison-Walker Co. and Stowe-Fuller Co.

On the other hand, plastic calcined magnesite is handled on a retail basis through building-supply agencies, and as the material deteriorates with age it cannot be stocked for long but must practically be made to order.

Before the war the price of Austrian crude magnesite per short ton delivered on our Atlantic seaboard was $9 to $10, and Grecian crude was generally valued at a little more than $10. California crude magnesite was about $8 a ton at the mines. The average price of

European calcined magnesite was about $16.25 a short ton, and dead-burned Austrian magnesite sold as low as $15.75 f.o.b. docks at Philadelphia, and $15.60 f.o.b. New York.

In 1921, according to the United States Geological Survey, the average value per ton of all crude magnesite sold or treated in California was $10.65. The price as marketed was variable and much higher. Most of the product was sold in the calcined form and the price varied with the color, whether lump or ground, whether packed in paper-lined barrels or shipped in bulk, and on the size of the order.

The market report published in the *Engineering and Mining Journal-Press*, July 8, 1922, was as follows:

Magnesite—Crude, $8@$12 per ton. High-grade caustic calcined, lump form, $30@$45 per ton. Plastic calcined, $45@$50 in barrels, carload lots, f.o.b. California points. Atlantic seaboard, $60.

Dead-burned Austrian grains, $30 per ton, f.o.b. Baltimore, Md.

Quality Figures in Selling Plastic Calcines

Although crude magnesite is sold largely on a price basis, the quality enters into the sale of plastic calcines. A product which experience has shown to be uniformly of higher quality than the current average of commercial materials can usually secure a premium over such products. The current price for calcined plastic magnesite, ground and packed in bags, is between $43 and $47 per short ton, f.o.b. producer's plant. Packages are included and are not returnable for credit. These prices are for high-grade material of superior physical properties. Lower prices may be obtained on inferior material. Contracts of 500 to 1,000 tons will take a reduction of $1 to $2 a ton from the above prices, depending on size of contract. California producers who have a long haul to the railroad and must shut down during the rainy seasons when roads are bad may make price concessions in order to move the maximum quantity of material just before the shut-down.

Prices Normally Fluctuate Little

Under normal conditions there are no great fluctuations in the price of magnesite. Less than carload quantities sell for a slight advance over carloads. The demand for the material is not affected by the period of the year. The use of magnesite refractories in the steel industries has no seasonal fluctuations, and as oxychloride cement, the form in which most plastic calcines is used, can be supplied in freezing weather, the demand for it is only slightly seasonal.

Dead-burned magnesite has been imported from Austria for many years, and calcined magnesite from Greece. The following table shows the quantity of magnesite imported in recent years:

TABLE II. MAGNESITE IMPORTED FOR CONSUMPTION IN THE UNITED STATES 1914-1921

Year	Crude		Calcined (not purified)	
	Tons	Value	Tons	Value
1914	13,354	$54,677	121,816	$1,323,194
1915	49,764	255,140	26,574	232,071
1916	75,345	634,447	9,269	204,183
1917	30,277	232,105	3,965	232,601
1918	5,432	103,233	19,049	824,022
1919	6,381	103,311	9,471	270,721
1920	33,549	406,204	14,779	373,165
1921	51,993	525,452	6,788	250,932

This gives total imports of 58,781 short tons in 1921, valued at $776,384. The origin of these imports as reported by the Bureau of Foreign and Domestic Commerce, Department of Commerce, is shown in Table III on the opposite page.

This table, however, is somewhat misleading for most of the magnesite credited to Italy, although shipped from Trieste, originated at Radenthein, Austria, and that shipped from Germany was mined in Austria or Czechoslovakia. Magnesite imported from Netherlands was either from Austria or Greece originally.

Domestic and Foreign Magnesite Compared

Probably there is no physical difference between the crude white Californian and Grecian magnesite for plastic purposes. With calcined material, however, it is presumed that California magnesite calcined in a rotary kiln with pyrometric control is better conditioned than any other plastic calcines.

There is very little difference in quality between Washington and Austrian magnesite for refractories. It has been claimed that where records have been kept in the steel and copper industries, costs of magnesite have always been lower when the Austrian was used. This may have been true when compared with Canadian magnesite or with the early domestic product, but I doubt if any appreciable difference could be recognized by an impartial observer between the quality of staying power of the dead-burned magnesite made in Washington in 1920 and the Austrian. The fact that the iron occurs naturally in the Austrian ore and was synthetic in the Washington product and therefore regulated to the proper amount is immaterial, as is also probably the slight difference in silica content.

Standards for Plastic Calcines Developed

To round out this article it seems fitting that a statement be included concerning advances being made in the method of calcining and in standardizing the product. The Northwest Magnesite Co. co-operated with the Berkeley Station of the U. S. Bureau of Mines in a laboratory investigation of different methods of calcining. The Bureau of Standards has made numerous experiments in calcining magnesite, using a miniature electric furnace. The National Kellastone Co. has been studying to improve calcining practice in a rotary kiln at Porterville, California, and the American Mineral Production Co. has built special kilns for this purpose near Valley, Wash.

The following statement regarding specifications is from a recent letter by H. F. Wierum, general manager of the American Mineral Production Co., of Valley, Wash.:

"The chemical requirements for plastic calcines are, within certain limits, of very little consequence. As burned by this company, the only detrimental effect of such impurities as silica and lime, is the lowering of the percentage of MgO. It is perhaps fully in place here to state that this company was the first company to point out plainly the fact that lime is detrimental only when it exists as the oxide. When the crude magnesite is calcined at a temperature far below that at which the calcium carbonate is decomposed, any lime that was present in the crude rock as carbonate, still existing as carbonate in the calcines, is as inert and free from chemical action as so much silica. Marble dust, as you doubtless know, is a favorite ingredient of many oxychloride mixtures, and this fact helped us greatly in convincing the flooring and stucco people that whatever small quantities of lime may be present in our plastic calcines are harmless. Recently, however, this very vital fact has been recognized by a great many producers, and efforts are being made to calcine within the limits of temperatures which leave the lime present as carbonate.

"It is not exaggerating to say that one of the main reasons why magnesite composition products, such as mag-

TABLE III. MAGNESITE, NOT PURIFIED, IMPORTED INTO THE UNITED STATES IN 1921, BY MONTHS AND COUNTRIES

Country	January		February		March		April		May		June		July		August		September		October		November		December		Total 12 Months	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Short Tons	Value
Austria	.....	.....	..	...	3,379	$83,997	50	$3,313	50	$1,378	.....	.....	4	$75	6,117	41,332	.....	.....	13	1,375	.....	.....	270	7,434	9,496	$125,329
Canada	.....	.....	..	...	40	1,612	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	427	15,195
Czechoslovakia	213	4,309	..	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	527	.....	.....	.....	.....	213	4,309
England	.....	.....	..	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	298	10,022	.....	.....	303	9,552	560	15,250	11	255	3,884	62,415
Germany	12	402	..	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,480	40,000
Greece	.....	.....	..	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	28	1,153
India-British	.....	.....	..	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	28	1,150	.....	.....	.....	.....	.....	.....	4,519	45,486	36,121	365,743
Italy	4,382	24,168	..	...	4,244	49,667	.....	.....	5,952	41,831	1,407	11,825	.....	.....	3,357	60,015	9,380	107,018	2,880	25,733	459	22,451	601	28,141	2,914	149,415
Netherlands	282	16,637	1	$95	100	5,971	315	18,155	33	1,916	207	11,518	237	12,056	149	6,460	100	6,092	431	20,018	19	2,324	4	956	90	7,482
Scotland	.....	.....	..	...	.....	.....	.....	.....	.....	.....	.....	.....	33	2,022	.....	.....	33	2,085	.....	.....	.....	.....	1,120	4,000	1,120	4,000
Venezuela	.....	.....	..	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	4,889	45,516	1	95	7,763	141,247	365	21,468	6,035	45,125	7,839	82,244	1,231	22,614	9,949	118,979	9,513	115,203	3,631	57,205	1,038	40,025	6,527	86,663	58,781	776,384

nesite flooring and stucco, found such little favor for so long a time, was that no two shipments, even when from the same mine and the same calcining kilns, could be counted upon to act the same, or to be uniform. This was because sometimes more and sometimes less of the rock was always overburned or underburned, according to the eye or the whim of a burner; therefore when this company started to make absolutely uniform calcines, and designed entirely different kilns with this end in view, it is not surprising that the idea of regulating both time and temperature of calcining to a nicety found favor and is now being adopted by many prominent producers.

"The calcines now being produced by us are made under absolutely uniform and unvarying conditions. Every carload, every ton, it might almost be said every sack of calcines produced, is made from rock of the same analysis and the same size, calcined at temperatures which do not vary 15 deg. C. and for periods which do not vary 15 minutes from pre-determined conditions.

"In view of all the above, both producers and consumers are now working together very heartily toward a set of physical specifications to govern shipments, which will completely do away with the necessity of chemical analysis. All details have not as yet been agreed upon, but certain producers are represented on a committee which is slowly working toward agreement on all points. So far we have about agreed on the following: First, on a typical stucco mix containing not more than 18 per cent of calcines and not less than 12½ per cent, and the balance consisting almost entirely of sand of different fineness and a little asbestos, the shrinkage or expansion shall not be greater than plus or minus $\frac{1}{10}$ of 1 per cent in 48 hr. after setting, or plus or minus $\frac{1}{100}$ of 1 per cent after full maturity. Second, that the modulus of rupture shall be not less than 550 lb. in 24 hr. after final set, and not less than 1,000 lb. seven days after final set, and that it shall be greater at three months than at seven days, and greater at one year than at three months. Third, the tensile strength at 24 hr. age shall be not less than 300 lb. to the square inch, and not less than 500 lb. at seven days. Fourth, that the effect of water shall be such that three periods of 12 hr. each, during which samples shall be continuously sprayed with water equal to the hardest rain, separated by two periods of 12 hr. each of drying in normal air, shall not reduce the modulus of rupture more than 60 per cent, tested immediately after the third soaking while still containing the maximum amount of water, and that upon thorough drying in normal air and temperature such samples shall recover their strength up to at least 80 per cent of their original strength measured fourteen days after setting. Fifth, the setting time is usually specified to be about as follows: The initial set to occur in not less than one hour and not more than four hours, and the final set to occur in not less than two hours and not more than six hours.

"These specifications are not as yet fully agreed upon, or adopted, largely because flooring manufacturers do not use anything like the mixture quoted above, and cannot draw any intelligent conclusions from tests of such mixtures. They demand (and I am one who is heartily in accord with the demand) tests on mixtures which approach as nearly as possible mixtures used by them, and this company is adopting this principle in its shipments to flooring people, making tests wherever possible, on the exact mixtures which are to be used by the consignee, or where this is not possible, making tests on typical flooring mixtures when the calcines are to be used for flooring, and on typical stucco mixtures when the calcines are to be used for stucco.

Conditions Governing Tests Yet to Be Agreed Upon

"Another point which is not fully settled, but which probably soon will be, is the matter of conditions which shall govern the making of tests, such as temperature of the atmosphere, humidity, and altitude. These are really difficult to govern; for instance, if a set of twelve test bars is laid on an iron plate where the temperature of the room is 70 deg. and if a so-called 'setting pat' is laid in the same room on a glass plate covered with oiled paper, it has been found repeatedly that the time of both initial and final sets may vary 25 or 30 per cent as between the test bars and the setting pat, as measured by the Gillmore needles. Again, it is proposed that the curing of test bars and briquettes shall be done between the temperatures of 60 and 80 deg. F. Frequently we find a difference of 25 per cent in both tensile strength and modulus of rupture, as between these two extremes of temperature; and to make matters worse, in case the temperature of the curing room should happen to go to 90 deg. or 95 deg., which is sometimes difficult to prevent on warm summer days, it is found that results will be as much as 100 per cent higher than the same test mixes would show at 65 deg. F.

"All these and many other matters are being thrashed out, and it is hoped to secure a thoroughly reliable set of specifications by which the excellence of any sample of magnesite can be accurately and scientifically measured and stated. We have gone far toward this goal already, and consumers certainly appreciate the improvement. Little or no talk is now heard of the chemical analysis required of a plastic calcine. Consumers want only to know how strong it is, how quick it will set, how much it will shrink or expand, and how resistant it is to water, and these things we are giving them within very narrow limits of error already.

Differences in Calcination

"The behavior of the California magnesite, which is amorphous like the Grecian, is very different, when it comes to calcine, from the behavior of the Washington magnesite, which is crystalline. Nine hundred to 1,000 deg. C. does not seem to impair the setting quality of the amorphous magnesite, whereas any temperature above 750 deg. C. practically destroys the setting quality of the Washington crystalline magnesite. Consequently the method of treatment best suited to each variety cannot be compared. The time during which magnesite is subjected to heat has a very important bearing upon the setting quality and strength, upon the resultant calcines, and also upon the water resistance.

"If tests now being made by this company are successful, it is hoped to provide a method whereby the actual activity

of the MgO contents of any calcines can be accurately measured and compared. Before attention was paid to the fine points of calcining, nearly all shipments were found to contain certain proportions of both dead-burned and under-burned material, and as these proportions varied, so did the strength and activity of the calcines vary in the formation of magnesium oxychloride. It frequently happened that a calcine showing by a chemical analysis, say, 88 per cent of MgO would not make nearly so strong a cement as some other calcine showing but 70 per cent of MgO. This was because a greater proportion of the latter was active, and it has been found that it is possible to calcine the crude in such a manner that all of the MgO present as such will be active. This is but another instance of the totally wrong conclusions that can be, and in fact that were for many years, drawn from chemical analyses, and if, as we hope, it is going to be possible to state accurately just how active a certain calcine is, it will surely be a great step forward.

"Even this, however, without certain qualifying data, might be misleading because the water-resisting quality of a calcine by no means necessarily follows the chemical activity in the formation of oxychloride.

"You can readily see from all the above that we have undertaken a highly technical, extremely interesting, and very important development in our efforts to reduce the oxychloride cement industry to a scientific and reliable basis. We feel that this is the only way of increasing the usefulness of this most important cement, and thereby increasing its consumption.

"Not to leave the question of the potentialities of the business altogether untouched upon, I might say that in the year 1921 over 40,000 houses were covered with magnesite stucco, in the east and middle west, and that approximately 36,000 tons of plastic magnesite were consumed in the oxychloride cement business in America. The cooperation between producers and consumers and the marked improvement in the scientific treatment of the industry is having its inevitable effect, and we confidently look forward to a time not many years hence when the production and consumption of plastic magnesite will greatly surpass the production and consumption of dead-burned."

Need of Perfecting Calcination Methods

Here, in the present writer's opinion, is the situation. The market for dead-burned magnesite is not likely to increase much and may decrease. On the other hand, the market for plastic calcined magnesite can be extended tremendously. There would seem to be no limit to the demand that might be created for magnesite as a covering for exterior and interior walls and floors of buildings. A demand can be developed, however, only on a standardized and dependable article. Mr. Wierum, as shown above, Max Y. Seaton, technical director of the National Kellastone Co., and C. S. Maltby, of San Francisco, are especially active in working toward the desired goal.

The domestic producer of plastic calcined magnesite has a large part of the United States as uncontested market anyway, and I believe should compete successfully in the rest of the country (the Atlantic Coast) on a quality basis when the dependability of the domestic product is recognized by the consumers. This condition can be brought about by perfecting the method of calcining. When that is done and the product is thoroughly reliable, the marketing of magnesite will be easier than now.

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